THERMOMETRUM MAGNUM;

O R,

GRAND STANDARD THERMOMETER.

EXPRESSING

All Degrees of HEAT and COLD, from that with
which Mercury BOILS, to that which congeals it
into *ſolid* METAL.

TO WHICH ARE ADJUSTED

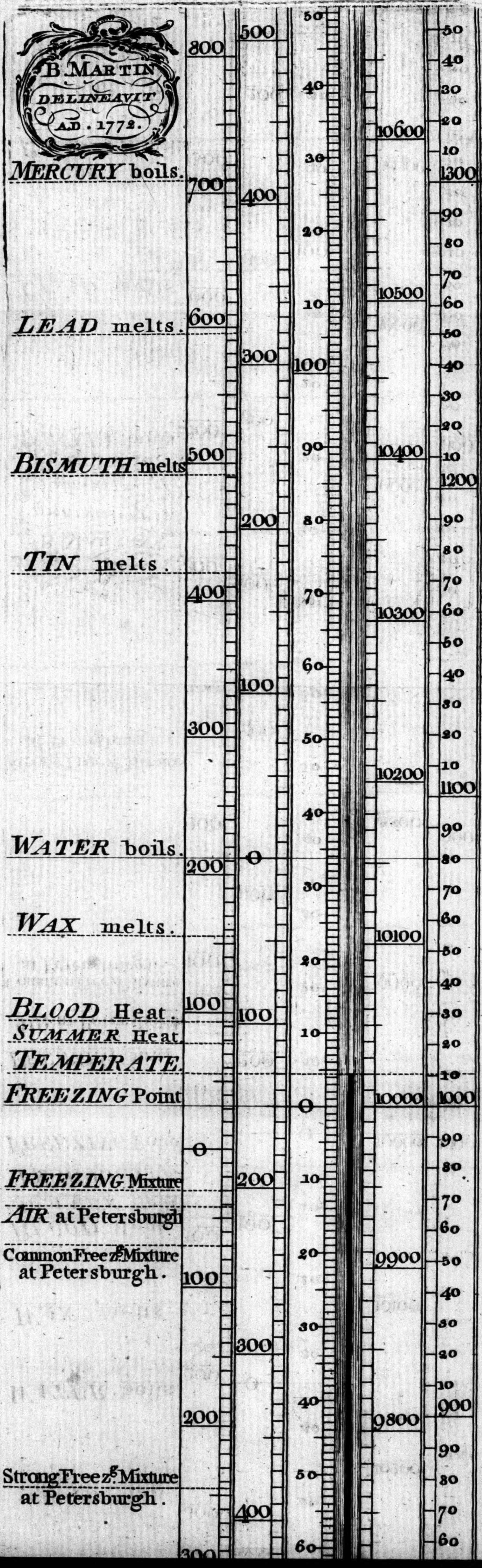
The celebrated SCALES of Sir ISAAC NEWTON, FAHRENHEIT,
De L'ISLE, and REAUMUR, for comparing Obſervations
made in every Part of the Globe, and in all Degrees of
Temperature in the Air, or any other Bodies.

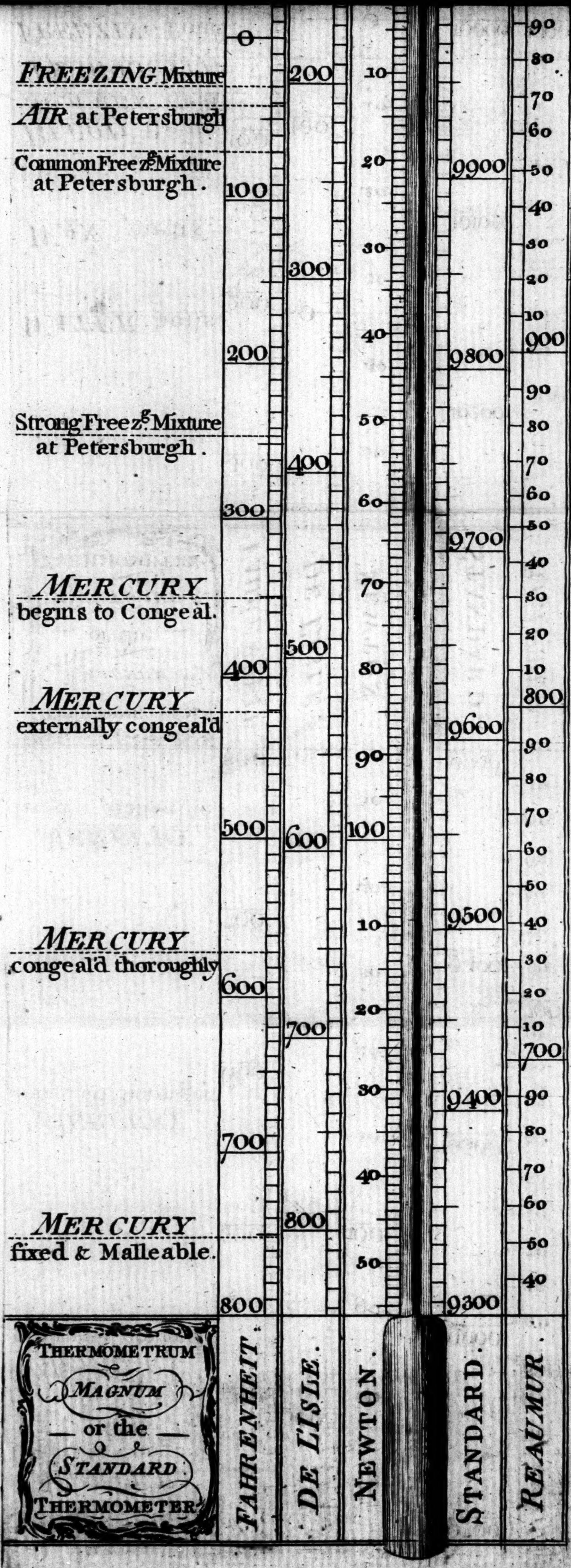
The Whole delineated on, and illuſtrated by, a Large
COPPER-PLATE.

BY BENJAMIN MARTIN.

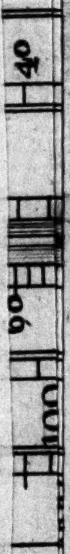
LONDON:
Printed for, and ſold by the AUTHOR,

In Fleet-ſtreet, No. 171, and by the Bookſellers in City
and Country. A. D. 1772.


B. MARTIN
DELINEAVIT
A.D. 1772.
MERCURY boils.
LEAD melts.
BISMUTH melts
TIN melts.
WATER boils.
WAX melts.
BLOOD Heat.
SUMMER Heat.
TEMPERATE.
FREEZING Point
FREEZING Mixture
AIR at Petersburgh
Common Freez^g. Mixture at Petersburgh.
Strong Freez^g. Mixture at Petersburgh.
10600
10500
10400
10300
10200
10100
10000



THERMOMETRUM
MAGNUM
or the
STANDARD
THERMOMETER



A DESCRIPTION OF THE STANDARD THERMOMETER.

AS I have but ſlightly touched upon the Nature and Uſe of the THERMOMETER in the Treatiſe on the BAROMETER, it may be proper here to give a further Account of an Inſtrument ſo generally uſeful, in itſelf ſo very curious, and which has arrived to it's greateſt Perfection only within twelve Years paſt, by the ſingular and amazing Invention of Mr. J. A. BRAUNIUS, of the *Imperial* ACADEMY OF SCIENCES at PETERSBURGH; of which the following is an Abſtract, tranſlated from his own Diſſertation on the Subject.

The *Thermometer* he uſed for the Purpoſes of exploring the moſt wonderful Extremes of Heat and Cold was that of *De* L'ISLE, which was divided from the Point indicating the *Heat of boiling Water* 10600 Degrees, above and below; and in ſome he mentions more than 800 to the

Bulb, which was, in his, of a *ſpherical* Form. But as *Fahrenheit*'s Scale is that in common Uſe, I have placed it by *De L'Iſle*'s on one Side, and that of Sir ISAAC NEWTON (as is generally ſuppoſed) on the other, as you obſerve in the Copper-plate of the *Grand Thermometer* annexed.

Mr. BRAUNIUS obſerves, that neither *Fahrenheit*, *Reaumur*, *Muſchenbroek*, nor any other Perſon before himſelf, had been able to produce an artificial Cold which would cauſe the ☿ to deſcend more than 40 Degrees below the Cypher (0) in *Fahrenheit's Scale*, which was 110 in his own; but that taking the Advantage of a very cold Air at *Peterſburgh* (*Dec.* 14, 1759), the ☿ ſtanding at 205, he made a freezing Mixture with pounded Ice and *Aqua Fortis*, which, upon immerging the Bulb of the Thermometer, ſunk the Mercury to 134 Degrees; which was 24 Degrees lower than had ever been ſeen before.

Fluſhed with this Succeſs, he reſolved to try what might be done with a Mixture of Snow and *Aqua Fortis*, and accordingly made one, in which, placing his Thermometer, the ☿ ſunk to 260, with a very few Drops of *Aqua Fortis*; and by putting in a little more, it ſunk to 380 immediately.

Mr. BRAUNIUS had ready by him another Glaſs filled with Snow, and taking the Thermometer out of the former, before it loſt much of its Cold, he placed it in this ſecond Mixture, and was agreeably ſurpriſed to obſerve the Mercury deſcend 470 Degrees.

He ſays, ſuch a ſtupendous Deſcent of ☿ induced him to think, at firſt, that it could not be owing to cold, but to a Fracture of the Bulb of his Thermometer; which, when he had taken out, he was rejoiced to find was entire and unhurt.

He now obſerved, for the firſt Time, that the ☿ was no longer moveable in the Tube, but remained without

Motion

Motion 12 Minutes in the open Air, cold to the Degree 203; and being carried into a Room 125 warm, after a few Minutes, the ☿ recovered its Fluidity, and began to aſcend.

He now began to conſider what might be done with other Sorts of Fluids in the Production of artificial Cold; with this View he tried various frigorific Mixtures, made with the following Liquors, and obſerved the Degrees through which the ☿ deſcended by each, as in the Table below.

Common Wines	6, 7, 8.
Spirit of Sal. Ammoniac	10.
Spirit of Sulphur	10.
Spirit of Hart's Horn	10.
Brandy	12.
Spirit of Wine Camph.	15.
Alchohol	20.
Sweet Spirit of Vitriol	20.
Spirit of Sea Salt	30.
Simple Spirit of Nitre	30.
Hoffman's Anodyne Liquor	32.
Oil of Vitriol	35.
Aqua Fortis	40.
Fuming Spirit of Nitre	58.

By theſe Experiments he was convinced, there was only one Liquor left for him to try, viz. the *Fuming Spirit of Nitre*, and this he did next uſe with amazing Succeſs; for having provided ſeveral Glaſſes filled with Snow, on *December* 25, he poured the Spirit of Nitre in one, and the ☿ ſubſided to 530; it there became motionleſs, and broke the Bulb of the Thermometer. He now firſt obſerved the ☿ ſolid, though not totally ſo, for a ſmall Quantity in the Middle of the Ball remained fluid. The external Surface of the mercurial Globe was continuous, polite, and hard; ſo that being put into a Mortar, it was beaten flat with the Peſtle, and appeared like Lead, emitting the ſame ſound when ſtruck; being reduced to thin Plates, they were cut with a Knife, and reſembled the Brightneſs of the pureſt Silver; but in about twelve Minutes they began to melt, and ſoon recovered the uſual Fluidity.

On *December* 26, the natural Cold of the Air exceeding any before, being at 212, Mr. *Braun* took the Opportunity of repeating his laſt Experiment in two Thermometers, and with ſuch Succeſs, that he obſerved the ☿ to ſink down to 650, and examining the Bulbs, found they were both cracked in ſeveral Parts, but yet adhered to the Mercury, which he obſerved was now juſt thoroughly congealed; and therefore he makes this Degree 650, the *Term of Cold for the Congelation or fixing of* ☿ *into a ſolid Metal.*

By repeating theſe Experiments under various Circumſtances, he was at length able to produce Deſcents of the ☿ to 680 and 700 Degrees; and at laſt to 800, and beyond. In this prodigious Degree of Cold, the Bulb broke to Pieces, the ☿ fell from the Height of three Feet to the Pavement, in Form of a ſolid Maſs, or Globe of *Mercurial Metal*, it was flatted by the Fall; in ſhort it was perfectly ſolid, ductile, malleable, &c. in all reſpects like a Globe of Lead, Tin, or Silver.

Thus all Degrees of Cold to that which congeals and conſolidates fluid Quickſilver into a hard Metal, have been explored and diſcovered by Experiment; and are expreſs'd in all the three Scales affixed to this GRAND THEMOMETER, as you ſee in the Plate.

The upper Part of this Thermometer expreſſes all Degrees of Heat to that with which Bodies appear *glowing* in Twilight. Mr. *Braun* has found by his Experiments the Degrees of Heat with which Tin, Lead, Biſmuth, &c. will melt, and Mercury boil; and theſe, with

with the Heat of Melting Wax, Boiling Water, Summer Heat, &c. are likewiſe marked on the Plate.

By Mr. *Braun*'s Experiments it further Appears that thoſe very Liquors which produced ſuch remarkable Degrees of Cold by their Mixture with Snow, will at the ſame time create conſiderable Degrees of Heat if mixed with Water, even the Water of diſſolved Snow. This Paradox in Philoſophy requires too prolix a Solution for the Preſent, if it will admit of any at all.

Mr. *Braun*'s Thermometer contains 1064 Diviſions between boiling Mercury 414, and the Cold which congeals it to a Solid 650; and therefore the Bulk of the Mercury in its boiling State, being made equal to 10000 ſuch Parts or Diviſions, it is evident, that its Bulk in a State of Solidity will be 8936 of thoſe Parts; and therefore it's Diminution in Bulk will be $\frac{1064}{10000}$, or nearly $\frac{1}{10}$ of the Whole; and of courſe it's Weight, or Specific Gravity, will be ſo much increaſed. But from a Temperate State of the Air to the Term of Congelation, there are but about 520 Diviſions; therefore its Contraction in Bulk when Solid, will be only $\frac{520}{10000}$, or about $\frac{1}{20}$ of its ordinary Bulk in a *fluid State.* It's Specific Gravity is now 14, but when made ſolid by Cold, it will be 14,7; and in its Boiling State, it will be 13,3.

Dr. *George Martine*, in his Treatiſe on the Thermometer, has given us a Plate of no leſs than 16 different Scales of Degrees or Diviſions for making Obſervations with this Inſtrument, uſed by different Perſons and Societies; among theſe only two begin the Scale at the *Freezing* Point, and Sir *Iſaac Newton* was the firſt of theſe; and no wonder, ſince this great Man could do Nothing but what was conſonant to the higheſt Reaſon, which undoubtedly points out that Degree of Temperature in the Air, by which the moſt common Fluids begin to *freeze or congeal*, as the proper *Term of Compariſon for*

Heat

Heat and Cold, in all Degrees above or below it; if there be any Reaſon in the Diviſions of the other Scales (particularly that of *Farenheit's* in common Uſe) I confeſs I am at a Loſs to find it.

By the *Decimal Diviſions* of the *Newtonian* Scale all Compariſons of Heat and Cold are greatly facilitated; thus if 12 repreſent the Heat of the Humane Body, then 24 the Heat of *melting Wax* is twice as great; and the Heat which *melts* Tin being 72 appears to be 6 Times as great; and, laſtly, the Heat of *boiling Mercury* is 126 which is 10½ Times that of Blood, Milk, Urine, &c. On the other Hand, the Cold of a common *freezing* Mixture, here at *London*, is alſo 12; and the Cold producing the utmoſt Condenſation of Mercury being 146, is more than 12 Times that of the Mixture.

But *Thermometers*, as they are commonly made, are little elſe than mere *Thermoſcopes*, that is, they rather *ſhew or indicate* the ſame relative Degrees of Heat and Cold, than *meaſure* them, as the Word *Thermometer* imports. Now in Order that they may be conſtructed to meaſure any Degrees in the Qualities of Heat and Cold, it muſt be conſidered that equal Degrees of Heat can only be meaſured by equal Expanſions of the Fluid; and therefore the ſeveral Degrees on the Scales of Thermometers ought to be ſuch as will adequately correſpond to, and meaſure the equal Differences of thoſe Expanſions of the Fluid, above or below ſome given Point; and that in the moſt immediate and facile Manner.

To this End, it will be neceſſary to fix on ſome Point, as a *Term* or *Boundary* between Heat and Cold; And as Sir ISAAC NEWTON has choſen this Term, which expreſſes that Temperament of the Air in which *Water begins to freeze*, or *Snow begins to thaw*, it would be preſumption to think of any other for the BEGINNING OF THE SCALE.

The Principle which Sir *Iſaac Newton* and *De L'Iſle* go upon is undoubtedly the beſt; but as OIL and SPIRIT are far from being proper Fluids for an univerſal Standard Thermometer, theirs could not be uſed in ſuch a character; nor can any Fluid be found for this Purpoſe but the pureſt MERCURY, as appears from what has been ſaid above.

The moſt convenient Form for the Bulb is by no means a *Globe*, as the Heat or Cold cannot ſo readily and inſtantly penetrate thro' ſuch a Body; it ought to be therefore of a long and flatted Figure nearly like that in the Plate; and the Tube having a proper Length, and Size of the Bore, is firſt to be nicely weigh'd in a moſt exact Ballance; and then to be filled with Mercury to the Top, as it ſtands in thawing Snow or Ice.

Secondly; The Bulb is then to be immerſed into *boiling Water*, the Heat of which will expel a certain Quantity of ☿ from the Tube, which muſt be carefully collected, and its Weight taken in Grains.

Thirdly; The length of the Bore left vacant by the Expulſion of the ſaid ☿ muſt be exactly meaſured in *Inches* 100dth Parts.

Fourthly; This being done, the Bulb of the Thermometer is to be held over the Flame of a Spirit-Lamp till it has driven out ſo much ☿, that the remainder may ſtand about the middle of the Stem when the Bulb is again put into melting Snow, and thus you will have the *Freezing Point* aſcertained, to be marked with a File.

Fifthly; From this Point you ſet off the before meaſured Diſtance or Length of ☿ expell'd by boiling Water, and that will aſſign the *Point of Boiling Water* in the Scale.

Sixthly; The Thermometer as now fixed to the freezing Point is to be very exactly weighed, and from this Weight deduct that of the empty Tube, and the Remainder will be the Weight of the contained Mercury.

Seventhly; Then ſay, As this whole Weight of ☿ to the freezing Point is to the Weight of that driven out by boiling Water, ſo is 10000 to a fourth Number A; this Number A will therefore expreſs how many of the 10000dth Parts of the whole ☿ are contained in the Mercury between the Points of Freezing and Boiling Water.

Eightly; Then ſay, As the Number A is to the whole Diſtance between theſe two Points, ſo is 100 to the Length of the Bore occupied by 100th Part of the whole Bulk of ☿ = 10000.

Ninthly; This Diſtance or Meaſure of 100 Parts is carefully to be ſet off from the Freezing Point above towards the Top of the Tube, and below towards the Bulb and each of theſe 100drs being divided into 10 equal Parts, they will adequately ſhew the Expanſion of the Mercury in 1000dth Parts of the Whole. And thus the Scale is compleatly finiſhed for Uſe.

In all that has been hitherto ſaid, it is ſuppoſed that the Bore of this Standard Thermometer-Tube is every where equal; which ought to be examined at firſt by letting a ſmall Quantity of ☿ move thro' the whole Length of the Tube, and then obſerving if it has the ſame Length in every Part; if ſo, it is fit for the Purpoſe, otherwiſe not.

The Number A above-mentioned, I have found in ſeveral Trials to fall between 150 and 155; and particularly in two Tubes with flat Bulbs it came out 153 to the 8th Part of a Grain. I have therefore given 153 Parts of 10000 to the Diſtance between the Freezing Point, and that of Boiling Water, in the *Standard Thermometer* of the annexed Plate.

Whoever will conſult Dr. G. MARTINE's Eſſays on theſe Subjects, will be ſatisfied that none of the numerous Conſtructions of this Inſtrument, which he has exhibited, are fitted for a Standard in this Kind. He has, with great

Judgment

Judgment, ſhewn, that the ſaid Number A which *Fahrenheit* makes 180, *De L'Iſle* 150, and *Reaumur* 80, cannot be depended upon for Exactneſs; but we have given them a Place here, as they ſerve to communicate and compare Obſervations made in different Parts of the World; as that of *Reaumur* in *France*, *De L'Iſle's* at *Peterſburgh*, and *Fahrenheit's* all over the Globe.

But as no Thermometer has yet been made to that Extent of Scale, as Nature and Uſe require, I have thought it might be acceptable to the curious and philoſophic Part of the Public to have this firſt Exemplar of ſuch a wonderful Conſtruction. Dr. MARTINE was aſtoniſhed at a Degree of Cold which cauſed a Deſcent of the ☿ to 275 below (0) in *De L'Iſle's* Thermometer at *Peterſburgh*; he could ſcarce think it credible; but what would he have thought, or ſaid, on hearing that in the Year 1760 it fell to 7 or 800 Degrees! and congealed the ☿, which the Dr. had denied to be poſſible! But what will not Time produce? We make ſuch Thermometers now (for ſuch as are willing to repeat thoſe amazing Experiments in very cold Climates) with the utmoſt Eaſe; and though that Extreme of Cold cannot be exhibited here, yet nothing is eaſier than to ſhew the other Extreme of Heat for boiling ☿ in the STANDARD THERMOMETER. And, by ſeveral Experiments, I have found it to be very near the ſame with that of Mr. *Braun*, as here marked in the Scales.

Philoſophers have propoſed a Method of inveſtigating Degrees of Heat much greater than that of ☿, when it boils, even to that of *glowing*, or *red hot Metals*; and, of courſe, to explore it where no Thermometer can be applied. They go upon this Suppoſition, *that the Degrees of Heat loſt by Bodies in equal Times, are as the remaining Degrees of Heat in thoſe Bodies at the Ends of thoſe equal Intervals of Time*; and if this were the Caſe, then the ſaid Degrees of loſt and remaining Heat would be in *geometrical Proportion*, while the Intervals of Time were in *arithmetical Proportion*; and granting this, nothing could be eaſier, than, (by obſerving the Time in which the Heat of red hot Metal became equal to that which the Thermometer could bear when applied to it, and afterwards the Time (in Minutes) in which the ☿ ſubſided to the Temperature of the ambient Air,) to find the Degree of Heat in the glowing Metal when firſt taken from the Fire; for, by this Means, the *logarithmetic* CURVE might be eaſily drawn to *expreſs all the Degrees of Heat* in the *Mercury* and in the *Metal* correſponding to every Minute of Time during the Obſervation, in the Manner directed in my *New and Compendious* SYSTEM *of* LOGARITHMS.

But the Virtuoſo has little Reaſon to hope for much Satisfaction in this Affair, for that the loſt Degrees of Heat are as the Remainders in equal Times, is an *aſſumed Poſition*, rather than a *real Truth*; beſides, were it actually Fact, the Heat of the ☿ could never become equal to that of the common Air, as is evident from the Nature of the before-mentioned Curve and it's Aſymptote; nor ſhould I have troubled the Reader with ſuch an *Hypotheſis*, had it not been aſcribed to Sir ISAAC NEWTON, and ſo largely treated of by Dr. G. MARTINE.

FINIS.